Sensory Integration and the Child with Hearing Loss

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Child Hearing Services
Program Demographics

- 81 children enrolled in weekly tx
- Other handicapping conditions: 37 have no other handicap other than SNHL
- Degree of Hearing Loss: 40 profound, 19 severe, 22 mod/sev or mild/mod
Program Demographics

- 42 have cochlear implants
- The rest have hearing aids
- Most have an FM system prior to age 3 years
- Follow and provide consultations for 21 children with an implant and many more children with hearing aids on a once 3-6 months or annual basis
Program Demographics

- Age range of children served: 3 months to adult, with the majority of clients ranging from birth to 10 years of age

- Communication Methodology
  - Aural/Oral & Auditory Verbal (73 children)
  - Total Communication (8 children)
Program Demographics

- Provide services to children and their families covering a large geographical region

- Upper East Tennessee, Lower East Tennessee, Middle Tennessee

- Many families commit to a 1-3 hour drive to receive services
CHS Provides:

- Comprehensive audiology and rehabilitation services (hearing evaluations, earmold impressions and selection, hearing aid and FM evaluations and fittings)

- Pre and Post Cochlear Implant Assessments, CI treatment and Mapping/Programming

- Mainstream Consultations/In-services
CHS Provides:

- Independent Communication Evaluations
- Professional Training Workshops (NECCI)
- Provision of Mentoring for Professionals and Centers
- Parent and Adolescent Support Groups
- Contracted audiological and treatment services for 18+ school systems
Cochlear Implant Teams

- William Merwin, M.D.
  Baptist Hospital and Children’s Hospital
  Cochlear Products

- John Little, M.D.
  Children’s Hospital
  Cochlear and Advanced Bionics Products

First child implanted in 1992
Program Goals: Components

- To educate students in aural rehabilitation and prepare them for a career working with the hearing impaired population
- 100% student participation in service provision
- Student Clinical Education Seminars and Individual Supervisory Conferences
- Aural Rehabilitation Concentration
Aural Rehabilitation Concentration

- Graduate students in Audiology and Speech Language Pathology may elect to pursue a Concentration in the area of Aural Rehabilitation.

- Students began completing these requirements in 1990 and the Concentration was officially recognized by UT’s Graduate School in 2001. Over 50 students have completed the Concentration.
Sensory Integration Dysfunction

My Story
Case History: Sean

- Traumatic Birth
- Crawled: 11 months
- Teacher Concerns: 12 months
- Walked: 15 months
- Weak trunk support
- W-posture when sitting
- Limited babbling
- Sensory Defensiveness
- Overly-Sensitive
Sensory Integration

What is it all about??
Statistics

- Estimated 5-10% of all children have disordered sensory integration (A. Jean Ayres)

- Carol Kranowitz “The Out-of-Sync Child” estimates the percentage is much higher
Sensory Integration

- Developed by an OT named A. Jean Ayres (1965, 1971)

- A theory to explain how difficulties in academic and motor learning in children with certain learning disabilities relate to the ability to integrate information from the senses
Sensory Integration

- Based on the assumption that our 7 senses (sight, sound, smell, taste, touch, vestibular, proprioception) work together to create a sense of self and the environment.
Senses

- Sight
- Sound
- Smell
- Taste
- Touch
- Vestibular: Movement and the pull of gravity
- Proprioception: Information about muscles and joints and body position
Sensory Integration

- For sensory integration to occur, environmental input is taken in through the senses

- Then sent through the nervous system to the brain to be processed to create a response
Sensory Integration

- If a child cannot regulate himself or herself to the environment, it will be very difficult for that individual to communicate within that environment
Why important for an SLP?

- Because many children with sensory processing disorders experience coexisting language and speech impairments, SLPs will most likely encounter children receiving SI services

(Cermak & Mitchell, 2006)
- Research demonstrates a correlation between language, speech production, and motor skills in children (Estil & Whiting, 2002)
- Consistent support for a subgroup of children with language impairment who also have co-occurring problems in motor coordination (Dewey, 2002)
Tallal and colleagues (1995) have proposed that an underlying deficit in temporal processing may affect both phonological speech production and motor production skills in children with language impairments.
Other researchers have suggested that a common mechanism underlying motor, speech, and language functions may be the vestibular or somatosensory sensory system (Tremblay, Shiller, & Ostry, 2003)

Some investigators therefore suggest that interventions designed to influence sensorimotor processes may also influence language functions and speech production (Reynolds, Nicholson & Hambly, 2003)
Why important for an audiologist?

- Nearly 40% of all children with hearing loss present with secondary handicapping conditions such as: learning disabilities, syndromes, and Sensory Integration difficulties (Schum, 2004)
SI Intervention

- SI therapy facilitates speech-language acquisition by enhancing the efficiency of sensory processing at the brain stem level, which then provides the foundation for more complex, higher level cortical processing, which is necessary for language development.
Sensory Integration

- Step 1: Sensory Registration: The process by which the brain is aware of new stimuli imposing on it

- Ex. Looking toward a loud noise when reading the newspaper on the patio
Sensory Integration

- Step 2: Sensory Modulation: Process by which we adapt to incoming information to maintain a balance or to respond to the stimulus

- Ex. The loud noise is the neighbor’s lawnmower, that is ignored and kept in the background as you continue reading, but can be brought back to conscious attention if necessary or if changed
For most children, sensory integration develops as the child matures, but for others, it does not develop as efficiently as it should.

This will lead to challenges in learning, development, or behavior.
Analogy

“Good sensory processing enables all the impulses to flow easily and reach their destination quickly. Sensory Integrative Dysfunction is a sort of ‘traffic jam’ in the brain. Some bits of sensory information get ‘tied up in traffic’ and certain parts of the brain do not get the information they need to do their jobs.”

(Ayres, 1994)
Sensory Integration Dysfunction

- Dysfunction in sensory integration (DSI)

- “Occurs when the brain inefficiently processes sensory messages coming from a person’s own body and his/her environment. The person has difficulty responding in an adaptive way to everyday sensations that others hardly notice.”
  
  (Kranowitz, 2003)
Sensory Integration

- SI provides a crucial foundation for later, more complex learning and behavior.

- The normal process of SI begins before birth and continues throughout life.

- Majority of DSI cases occur prior to the teenage years.
DSI

- Different from person to person
- Can vary from day to day
- Factors affecting DSI: fatigue, emotional distress, hunger
- May co-exist with other handicapping conditions (ADHD, Autism, Down Syndrome, Hearing Loss)
- Can be severe or mild
- Can occur continuously or occasionally
DSI Suspected Causes

- Brain damage
- Genetic predisposition
- Trauma at birth (lack of oxygen)
- Premature birth
- Environmental toxins

- Prenatal circumstances: exposure to chemicals, toxins, drug/alcohol abuse, certain medications
- Lengthy hospital stay at birth
Sensory Integration

Why is it important?
Sensory Integration Function-Important for:

- Academic Skills
- Attention
- Auditory Perception
- Balance
- Bilateral Coordination
- Body Awareness
- Fine Motor Skills
- Visual Perception

- Hand Preference
- Muscle Tone
- Self-Esteem
- Social Skills
- Speech/Language
- Tactile Perception
- Hand-Eye Coordination

(Kranowitz, 2003)
Sensory Integration

- Speech and Language acquisition depends on multiple sensory processes

- Integration of the sensory system is the foundation for successful development of motor skills, organization, attention, and interpersonal relationships (Mauer, 1999)
Sensory Integration

A physician study in a Learning Disorders Clinic
Physician Study

- Dr. Brock Eide and Dr. Fernette Eide, Spring 2004; Edmonds, WA

- Combining patient history and clinical observation, determined that of their last 50 consecutive patients, 52% had difficulties with sensory integration severe enough to contribute to their learning problems
Physician Study

- Of 30 children under age 10, 70% had DSI, while in children 10 and over, only 20% had DSI.

- Reasons for this difference not clear.

- Possible that the incidence of DSI diminishes with age because the sensory processing disorder tends to lessen or resolve.
Physician Study

- Also possible that the sensory processing disorder persists, but that many children tend over time to develop compensatory strategies for dealing with it so that it no longer produces so many bothersome complications
Physician Study

- In the study (N=50 children), parents of children diagnosed with DSI were over 5 times more likely than parents without DSI to say that their child:
  - Had a weak grasp and floppy muscle tone
  - Was insecure on slides and escalators
  - Avoided rough play and playground equipment
  - Had unexpected falls while sitting in a chair or playing
<table>
<thead>
<tr>
<th>Item</th>
<th>DSI</th>
<th>Non-DSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexpected falls</td>
<td>19%</td>
<td>0%</td>
</tr>
<tr>
<td>Floppy, loose muscle tone</td>
<td>29%</td>
<td>5%</td>
</tr>
<tr>
<td>Weak Grasp</td>
<td>29%</td>
<td>5%</td>
</tr>
<tr>
<td>Doesn’t like rough housing</td>
<td>19%</td>
<td>5%</td>
</tr>
<tr>
<td>Doesn’t like messy play, splashing in water</td>
<td>29%</td>
<td>10%</td>
</tr>
<tr>
<td>Fatigues Easily</td>
<td>52%</td>
<td>19%</td>
</tr>
<tr>
<td>Avoids physical closeness</td>
<td>19%</td>
<td>10%</td>
</tr>
<tr>
<td>Item, cont’d</td>
<td>DSI</td>
<td>Non-DSI</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td>Covers ears to loud noises</td>
<td>52%</td>
<td>29%</td>
</tr>
<tr>
<td>Has Tantrums</td>
<td>71%</td>
<td>46%</td>
</tr>
<tr>
<td>Clinical Finding</td>
<td>DSI</td>
<td>Non-DSI</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Abnormal Muscle Tone</td>
<td>58%</td>
<td>29%</td>
</tr>
<tr>
<td>Scapular Winging (muscles too weak to hold shoulder blades together)</td>
<td>38%</td>
<td>21%</td>
</tr>
<tr>
<td>Finger Agnosia (can’t feel their fingers in space)</td>
<td>86%</td>
<td>52%</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>50%</td>
<td>9%</td>
</tr>
<tr>
<td>Impulsivity</td>
<td>31%</td>
<td>8%</td>
</tr>
</tbody>
</table>
Sensory Integration Dysfunction

Diagnosis
Diagnosis

- Qualified occupational or physical therapist (Mauer, 1999)

- American Occupational Therapy Association and Sensory Integration International recommend specific evaluation and training guidelines
Recommended Guidelines

1. Medical and developmental histories

2. Observations and interviews (with caregivers/school environment)

3. Standardized tests (i.e. SIPT)

(Mauer, 1999)
Assessments

- Southern California Sensory Integration Tests (SCIT) (Ayres, 1972, 1980)

- Southern California Post-rotary Nystagmus Test (SCPNT) (Ayres, 1975)

- Sensory Integration and Praxis Test (Ayres, 1989)
Sensory Integration and Praxis Test (SIPT)

- A standardized tool that measures the sensory integration processes by uncovering how children organize and respond to sensory input

- Used for children between ages 4 and 8 years old
SIPT

- Consists of 17 brief subtests which measure visual, tactile, and kinesthetic perception, as well as motor performance

- SIPT can be given in 2 sessions, each consisting of 1-1 ½ hours

- Takes 2-3 hours to score and 2-3 hours to interpret

- Evaluator compiles results to explain findings and describe a treatment plan
SIPT Subtests

- Space Visualization
- Figure-Ground Perception
- Standing and Walking Balance
- Design Copying
- Postural Praxis
- Praxis on Verbal Command
- Manual Form Perception
- Finger Identification

- Localization of Tactile Stimuli
- Sequencing Praxis
- Constructional Praxis
- Post Rotary Nystagmus
- Oral Praxis
- Bilateral Motor Coordination
- Motor Accuracy
- Kinesthesia
- Graphesthesia
Checklists

- Infants and Toddlers Checklist (Birth to Age Two)
- Preschool Checklist (Ages 3-4)
- School-Age Checklist
- Adult/Adelescent Checklist (12+)
  (Occupational Therapy Associates-Watertown, P.C.)
  (Koomar et al, 2005)
Checklists

- Balzer-Martin Preschool Screening-Teacher Checklist
- Balzer-Martin & Kranowitz, 1992
Balzer-Martin Preschool Screening-Teachers Checklist

- Toleration of light/unexpected touch
- Participation in messy activities
- Ability to sit upright in chair
- Movement coordination
- Atypical behaviors for age (i.e. drooling)

- Use of both hands together when necessary
- Consistent hand preference?
- Ability to work with scissors, markers
- Attention in classroom
- Auditory language abilities
SI Therapy

- Sensory integration-based OT is highly recommended

- PT

- ST

- School support/participation

- Home environment
Central Nervous System

What does it do?
Central Nervous System

- Comprised of the brain and the brainstem, the spinal cord, and the nerve attachments, which communicate with the body’s cells, tissues, muscles, and organs

- Within just 18 days of conception, it is the first body system to develop

  (Chapple, 2005)
Central Nervous System

- Encompasses a communication network of over 45 miles of nerves, which send vital messages between the brain and body at a rate of 325 miles per hour
Within a 24 hour period, the communication of this system is responsible for:

- Over 103,000 heartbeats pumping 2,100 gallons of blood
- Over 23,000 breaths
- Thus exercising about 7 million brain cells

(Chapple, 2005)
Central Nervous System

- The nervous system’s importance to the body is highlighted by the fact that it is incased in bone (the brain by the skull; the spinal cord by the spinal column)
Central Nervous System

- Improper biomechanics or boney mechanics can negatively impact the body’s nervous system reception, affecting the body sense of position (proprioception), motion, balance, muscle tone, coordination, motor planning, and auditory language processing (vestibular sense)

(Chapple, 2005)
Central Nervous System

- Also affected is touch perception (tactile sense) essential for academic learning, emotional security, and social skills
Central Nervous System

- The 12 cranial nerves located at the brain stem are additionally significant to the body’s effective and appropriate sense of smell, sight, taste, and hearing.
Central Nervous System

- The CNS and its intimately related boney protection system are a profound link between a person’s external and internal environments, especially one with special needs.

- This link is critical in enabling a person to interact with his or her surroundings and with others.

(Chapple, 2005)
Central Nervous System

Three Underlying Systems: Tactile, Proprioceptive, Vestibular
Tactile System

- Location: Touch receptors in skin

- Functional Components:
  - 1) Protective: Alerts child to danger
  - 2) Discriminatory: Provides info about the qualities of objects in the environment (hard, soft, sharp, dull, rough, smooth)
Tactile System

- Affects Body Awareness

- Child must have knowledge of his own body before he can relate it to the environment and the spatial relationships of objects in the environment
Tactile System

- Affects Motor Planning
- The ability to perform motor movements in a smooth, coordinated manner.
- Motor tasks should be performed automatically (i.e. writing, skipping, riding a bicycle)
Hyposensitive Tactile System

- This child: May get hurt and not realize it.

- May know that he was touched, but not exactly where.

- May have poor body awareness.

- May not realize when he drops an object (i.e. book, pencil, jacket)
Hypersensitive Tactile System

- This child: is overly sensitive to being touched, especially when it is unanticipated.

- Note: This is NOT the result of a problem with interpersonal relationships, but rather a negative reaction to touch.
Hypersensitive Tactile System

- Difficulty standing in line between children.

- Purposely lashes out at children because he can’t tolerate close proximity.

- Doesn’t tolerate sitting in chair, squirms, sits on edge of chair
Hypersensitive Tactile System

- Is choosy about fabrics in clothing (may dislike rough textures)
- May not like long sleeves
- May not like having skin exposed (obsessively pulls elastic pants legs down when they creep up legs)
Sensory Integration Dysfunction

Case History #1: 23-month-old
<table>
<thead>
<tr>
<th>Hearing Loss:</th>
<th>Birth:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev-Prof. loss in right</td>
<td>Normal delivery</td>
</tr>
<tr>
<td>Mod-Sev. loss in left</td>
<td>No complications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GERD</th>
<th>Meningitis-8 wks. Old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure-to-Thrive</td>
<td>Motor delays-fluid</td>
</tr>
<tr>
<td>Controlled with meds and special</td>
<td>P.E. tubes; tonsils,</td>
</tr>
<tr>
<td>formula</td>
<td>adenoids removed</td>
</tr>
<tr>
<td>Began OT and PT when she was 21 days old</td>
<td>Aversion to soft textures and chewy foods</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Typical cognitive skills; Appropriate play skills</td>
<td>Receptive/Expressive Language Delay</td>
</tr>
</tbody>
</table>
Goals/Objectives

- Increase sound awareness to Ling Six Sounds (3 feet in quiet)
- Increase CVCV imitation
- Imitate 1-word utterances

- Improve receptive and expressive vocabulary
- Wear hearing aids throughout all waking hours
- Comprehend 1-step commands
Pre-Writing

Developmental Milestones
Pre-Writing: Developmental Highlights

- Birth-1 year: Basic foundation, reach, grasp/release, attends visually to others’ scribbling.

- 1-2 years: Banging of crayons, spontaneous scribbling; horizontal, vertical, circular strokes; bilateral scribbling; crayons held in fingers vs. palm by 1 ½ years

(Levine, 1995)
Pre-Writing: 2-3 years

- Imitates vertical and horizontal lines and circles
- Traces plus signs and squares
- Artwork consists of dots, vertical and horizontal lines, and circular strokes
- Begins to stabilize paper with non-drawing hand (not always efficient)

(Levine, 1995)
Pre-Writing: 3-4 years

- Preference for one hand, but hand switching continues
- Colors within the lines, not always successful
- Copies horizontal lines/circles (3 years)
- Traces lines/diamond shapes
- Copies large capital letters

(Levine, 1995)
Pre-writing: 4-5 years

- Dominance usually established between 4-6 years
- Colors within the lines
- Recognizes the shapes of five capital letters and copies simple words
- Represents objects from the real world in drawings

(Levine, 1995)
Pre-Writing: 5-6 years

- Some write letters, words, and names from memory
- Letter reversals common, little awareness or control of spacing
- Desires to write
- Fine localized movement of finger joints for small controlled strokes

(Levine, 1995)
Handwriting Without Tears

2004
Print Concepts/Metalinguistics
Understand:

- Words used in instruction: beginning, medial, final, etc.
- The purpose of reading: print carries the message
- Different forms of print: case, size, font, color
- Print corresponds to speech, word for word
- How stories work: beginning, middle, ending
- Concept of word and word boundaries
- Difference between a letter, sound, syllable, word, sentence
- Parts of a book: cover, title page, table of contents, etc.
- Directionality: left to right and top to bottom
- Punctuation marks
Alphabet Recognition

- Visually recognize and match letters to sounds in their different contexts and forms
  - Uppercase manuscript
  - Lowercase manuscript
    - Block/Vertical vs. DeNealian/Italic
  - Uppercase cursive
  - Lowercase cursive
Alphabet Recognition

- Must distinguish between letters that are similar in appearance
- More common letters should be taught before less common (a,t before q,z)
- Visually confusing letters should be taught far apart
- Combine explicit instruction in recognizing and writing with frequent exposure to printed texts
### Letter Pairs Often Confused

<table>
<thead>
<tr>
<th>Lower case</th>
<th>Upper Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-d</td>
<td>C-G</td>
</tr>
<tr>
<td>a-o</td>
<td>V-Y</td>
</tr>
<tr>
<td>b-d</td>
<td>I-J</td>
</tr>
<tr>
<td>b-q</td>
<td>E-F</td>
</tr>
<tr>
<td>b-h</td>
<td>L-T</td>
</tr>
<tr>
<td>b-p</td>
<td>K-X</td>
</tr>
<tr>
<td>b-q</td>
<td>O-Q</td>
</tr>
<tr>
<td>c-e</td>
<td>M-W</td>
</tr>
<tr>
<td>c-o</td>
<td>U-V</td>
</tr>
<tr>
<td>d-g</td>
<td>D-O</td>
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<td>d-p</td>
<td>I-L</td>
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<td>d-q</td>
<td>M-N</td>
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<td>f-t</td>
<td>P-R</td>
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<td>g-p</td>
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<td>g-q</td>
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<td>m-w</td>
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<td>u-v</td>
<td></td>
</tr>
<tr>
<td>v-w</td>
<td></td>
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<tr>
<td>v-y</td>
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</table>
Written Language
Explicit Handwriting Instruction

- Writing is a key component in literacy instruction
- Handwriting instruction can prevent some cognitive problems
- Handwriting instruction can help develop
  - Letter knowledge
  - Attitudes about writing and reading
  - Positive self-esteem
Research Findings related to Explicit Handwriting Instruction

- Improves letter knowledge, writing and attitudes toward writing than instruction on phonological awareness
- Illegible handwriting can affect school achievement and self esteem
- Kinesthetic learning is a strong reliable channel for most children to learn
Foundations of Writing

- Encouraging a child to write without showing him how is not beneficial. Why?
  - Children want to communicate what they know in their minds. If they have to focus on making letters, they are not considering the content of what they want to say
  - Drawing words will make them unhappy writers
  - Quality of essays will improve if mechanics of writing is easier and automatic
Handwriting Without Tears
Jan Olsen www.hwtears.com

- Adopted by many state boards of education including TN
- Pre-K-early elementary
- Developmentally based
- Inclusive
- Multi-sensory teaching aids and materials
- Usable for group and or individual
- Clear and easy to follow lesson plans
- Little time needed for prep
- Puts learned skills into immediate use
- Built in review of learned skills and fluency
Which alphabet is developmentally appropriate?

- By age three, children compose drawings with the same basic lines as manuscript letters: vertical lines, horizontal lines, and circles.
- Modified italic letters use complicated strokes which are actually cursive letters without beginning and ending strokes.
Which alphabet is easier to write?

- Four strokes are easy to master in vertical manuscript
- Slanted manuscript requires 12 different strokes
- Legibility of slanted manuscript is poorer than vertical manuscript
Which alphabet is easier to read?

- Vertical is easier...highway signs, public signs, newspapers, novels, textbooks, computers, televisions, often use vertical manuscript letters because they can be read quicker and easier.

- When readability is important, vertical block letters are often favored.
Which alphabet is easier to teach?

- Usually children know some vertical manuscript upon entering school. If slanted manuscript is used, then children have to re-learn strokes and letters that they could already write.

- Re-teaching is involved so, it is more difficult and time consuming to teach.

- Should not teach writing letters a different way than the child is reading them in children’s books.
Does slanted manuscript help with students’ transition to cursive?

- No research to support the claim that slanted facilitates transition from print to cursive

- Only 20% of DeNealian print letters actually easily transitions into cursive letters
Effective Teachers/Therapists

- Understand the nature of reading, know how proficient readers read, know how to teach students to read, understand which skills need to be developed at which points
- Understand listening and auditory training is crucial to the whole

- Print concepts
- Alphabet recognition
- Phonemic awareness
- Decoding/phonics
- Fluency
- Spelling
- Vocabulary dev.
- Syntax/morphology
- Comprehension strategies
- Writing
“Reading is the most important skill for success in school and society. Children who fail to learn to read will surely fail to reach their full potential” (Hall and Moats, 1999)

“Reading failure reflects not only an educational problem, but a significant public health problem as well.” (NICHD)
Central Nervous System

Proprioceptive System
Proprioceptive System

- Location: Muscles and joints

- Function: Gives info to the brain about where the body parts are and what they are doing

- Ex. Child is able to copy sentence from chalkboard (shifting focus from chalkboard to paper and back again)
Poor Proprioception: Signs

- Stiff, uncoordinated movements
- Clumsy, falls frequently
- Crash into objects in the environment
- Difficulty dressing/undressing
- Difficulty seating self in chair (overshoots/undershoots)
Poor Proprioception: Signs

- Holds pencil so hard, point breaks
- Difficulty going up/down stairs
- Slaps feet when walking (desiring additional feedback)
- Can’t do things without looking
Central Nervous System

Vestibular System
Vestibular System

- **Location:** In the inner ear

- **Function:** Provides info about where our body is in space, whether we or the surroundings are moving

- Tells whether movement is up, down, fast, slow, or angular
Vestibular System Affects:

- Balance

- Muscle tone: child may slouch, tires easily, may not like physical activities

- Bilateral Integration: Ability to coordinate 2 sides of the body

- Oculomotor/Visual perception: weak neck muscles, poor head stability affect eye movement development (child must be able to use eyes together in coordinated manner to follow horizontal line for reading)
Vestibular System Affects:

- Auditory Language Center: Word understanding and speech due to inner ear location and connection with the brain.

- The Vestibular System helps brain process what is heard. Increased verbalization frequently occurs following movement experiences.
Poor Vest. System: Signs

- Trouble: spacing letters/words on a line, size constancy of letters
- Difficulty staying between 2 lines
- Number/letter reversals
- Right/left discrimination difficulty
- Poor concepts: up/down, before/after
Poor Vest. System: Signs

○ Directionality in sports (may run to opponent’s goal)

○ Fine motor activities requiring spatial accuracy (i.e. pasting)

○ Reason: If you use half your mental energy to control balance, you have only the other half to process information

○ BUT: if you use only 1/10th of that energy for postural control, then 90% is available for cognitive activities (Murphy, 2006)
Balance: What and When

- About 2 months: Head control
- 6-7 months: Sitting
- 8-10 months: Crawling
- 9-10 months: Standing with support
- 9-16 months: Standing independently
- 9-17 months: Walking
- 21-30 months: Running smoothly
- 4-5 years: Hopping on 1 foot
- 5-6 years: Skipping

(Murphy, 2006)
Sensory Strategies

How do they affect brain development?
SI Intervention

- SI intervention procedures are based on the premise that plasticity exists within the CNS (Mauer, 1999)

- Hypothesized that neural systems that impair function may be remediable

- The control of tactile, vestibular, and proprioceptive sensory inputs is believed to enhance nervous system function (Fisher & Murray, 1991)
Sensory Integration Therapy: A study

- It has been hypothesized that improvement in SI may lead to increased language skills in general.

- Children with problems in the auditory language domain made significant gains in reading, compared with a matched control group after a program of SI (Ayres, 1972).

- Ayres hypothesized that the possible effectiveness of motor activity on language function may relate to enhanced interhemispheric integration at the brainstem level.
Neural Plasticity

- Neural plasticity describes the malleability of the brain.

- A child’s brain is particularly plastic, but it should be noted that some degree of plasticity has been found to exist throughout the life span.

- As a child interacts with a sensory rich environment through SI therapy, it is hypothesized that gradual changes are made to the way the brain processes information so that the child will be able to function more effectively.
Sensory Strategies:

- Promote dendrite growth and density
- Promote myelination
- Enhance neurotransmitter system (through influence on serotonin)
- Reset faulty interpretation of sensation

(The Psychological Corporation, 1982)
Sensory Strategies:

- Reinforce more effective neural circuitry
- Promote improved communication throughout the brain
- Improve brain arousal
- Improve cerebral efficiency (proprioception and movement)

(The Psychological Corporation, 1982)
Sensory Motor Input:

Calming or Alerting Qualities
Tactile

- Alerting Qualities: light touch, rough textures, cold to the touch, sharp corners, cold/cool environment

- Calming Qualities: pressure touch, tight wrap, firm stroking over large area, soothing/comforting, source is smooth or warm to the touch, warm/hot environment

(Hanschu, 1996)
Proprioceptive

- Alerting Qualities: fast paced, quick changes, unexpected changes, jarring or jerking, stops/starts abruptly

- Calming Qualities: joint compression, slow stretch, heavy resistance, continued resistance, slowly alternating push/pull

(Hanschu, 1996)
Vestibular

- Alerting Qualities: fast, jerky, changing directions, add visual with it, moving in suspended equipment

- Calming Qualities: slow, rhythmic, linear movements in one direction, using grounded equipment

(Hanschu, 1996)
Sensory Integration Dysfunction

Case #2: 7-year-old
- Born with bilateral, profound sensorineural hearing loss

<table>
<thead>
<tr>
<th>OT and speech therapies</th>
</tr>
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<tbody>
<tr>
<td>- Currently attends aural habilitation 2 hours weekly</td>
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- Klippel-Feil Syndrome
  - 3 open-heart surgeries

<table>
<thead>
<tr>
<th>Mainstreamed with interpreter</th>
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<tbody>
<tr>
<td>- Cochlear implant at age 3; Re-implanted at age 6 due to device failure</td>
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</table>
Goals/Objectives:

- Discriminate word vs. sentence
- Detect new speech signal in the presence of background noise
- Speechread words in a set of choices
- Imitate suprasegmentals (A/O)
- Correctly produce CVCV syllables imitatively
- Imitate various vowels and consonants
- Improve sound awareness in new environments
- Recognize her name
Visual

- Alerting Qualities: Unexpected visual stimuli, bright colors/lights, red/yellow shades, black on white, changing/moving, patterns of light

- Calming Qualities: Rhythmic patterns, blue-green shades, dim or dark, familiar, predictable

(Hanschu, 1996)
Auditory

- Alerting Qualities: Unexpected, loud, complex or mixed
- Calming Qualities: Expected or familiar, quiet, gentle rhythm, simple, melodic or sing-song

(Hanschu, 1996)
Olfactory

- **Alerting Qualities**: All odors tend to be alerting

- **Calming Qualities**: Familiar odors which can be associated with pleasurable and comforting experiences, interactions, or people

(Hanschu, 1996)
The Brushing Protocol
For Sensory Defensiveness
Brushing Protocol

- Recommended for children with Sensory Modulation Dysfunction (SMD)

- Used for children with sensory defensiveness

- AKA: Wilbarger Approach (Designed by P. and J. Wilbarger)
Neurobiological Effects

- Deep Pressure Touch (DPT) affects the Central Nervous System

- The parasympathetic system is directly affected by DPT. It relaxes us and tells our sympathetic system (one responsible for fight/flight responses) that it is okay to “come out and play”
Neurobiological Effects

- Dopamine is enhanced through DPT by reacting directly with the limbic system.

- The limbic system is the “pleasure center” of our brain. Through this system, we feel love, joy, and pleasure.

- This system is important for our ability to form relationships.
Neurobiological Effects

- DPT increases a chemical called Neurotrophines (nerve growth).

- This chemical is like a fertilizer for neurons (helping them to grow).

- This, in turn, enhances circuitry building and myelination.

- DPT receptors are located in the skin.
Neurobiological Effects

- Proprioception receptors are located in the tendons, muscles, and joints.
- The joint compression portion of the protocol, fires these receptors. They then enhance the chemical “Seratonin”.
- Proprioception helps the child to become more “aware” of their body.
Why important?

- The sense of “me” is important because without it, you are not able to respond to and interact with external sensations!!

- When a person gets a quick, strong release of serotonin, they receive an endorphin release as well.

- Endorphins help rid the body of stress chemicals.
Postrotary Nystagmus

- Spinning Protocol

- Nystagmus: A series of automatic back and forth eye movements.

- Rotary movement (rotation of the body) followed by an abrupt stop normally produces postrotary nystagmus.

- Duration/regularity of this reflex indicate vestibular system efficiency (should occur 10 times in 20 seconds).
Weighted Blankets and Vests

Proprioceptive Input
Weighted Blankets

- Weighted blankets provide proprioceptive input
- The deep pressure leads to a calming sensation
- Different blanket weights for different body sizes
- Weight needs vary with individual preferences
Weighted Blankets

- Each blanket contains pockets that can be customized, changed, or omitted, depending on child’s needs.

- Different pressure areas can be customized for different parts of the body.

- Ex. If more input is needed on the trunk, more weight can be applied in the middle of the blanket, less on the feet.
Weighted Blankets

- Website “Under Cover Angels”

- Can be used in school or therapy sessions as calming technique

- Weighs 6 lbs., easy to carry in gym bag

- OT’s recommend that the assembled blanket = no more than 10% of your body weight
Weighted Vest: Research

- Nancy L. VandenBerg (2001): Deep pressure applied by a weighted vest increased on-task behavior while the child performed fine motor activities

- Deep pressure can calm an over-stimulated nervous system
Sensory Integration

Treatment
My Story: Davis

- Unintelligible
- Language Delay
- Speech/Language Eval: 23 months
- HX of ear infections: 7 sets P.E. tubes in 6 years
- HX of conductive hearing loss
- Speech TX 2 hours weekly: 2-5 years of age
- OT Eval: 4 years; 3 months
- Delays in fine motor, visual-perceptual, sensory integration
- OT TX: 1 hour weekly: 4-6 years of age
- Fast ForWard: 2006
- Interactive Metronome: 2007
My Story: Davis

- Age appropriate speech/language skills
- Age appropriate sensory integration skills
- Performs well academically: 2nd grade
- Continues to struggle with handwriting
- Reputation as a good athlete in all sports
Sensory Integration Therapy

- Through sensory integration therapy, the brain has the ability to change

- The nervous system will then allow for accurate sensory registration, processing, and modulation

- This is done by providing the appropriate types and amounts of sensory input during child-directed activities

- Child is an active participant

- Therapy should be FUN for the child!
Sensory Integration Therapy

- SI therapy aims to set up a sensory environment to help promote adaptive responses and encourage the child’s inner drive.

- With each adaptive response, children become better able to integrate sensory information and become more confident in their abilities.

- Confidence in their abilities to interact successfully with the environment increases their drive to seek out new and challenging experiences and further enhances SI (Cermak & Mitchell, 2006).
Childhood play

- Years ago: Sensory-rich experiences

- Swinging, climbing trees, roller-skating, riding bikes, jumping rope, building sand castles, throwing snowballs, stomping through mud puddles, running through the sprinkler

(Kranowitz, 2003)
Childhood Play

- 2005: “Play” is soccer or gymnastics
- Staring at a TV, computer, or Play Station
- Sometimes old-fashioned is better!
- We need experiences that target all senses (sight, touch, smell, taste, etc.)

(Kranowitz, 2003)
Sensory Integration Therapy

- Movement-based therapy encouraging gross movements in many planes using large pieces of therapeutic equipment

- Suspended equipment, scooter boards, tunnels, therapy balls, tactile mediums, and vibration
Sensory Integration Therapy

- The equipment promotes movements including flexion, extension, and rotation, movement of the body in space, and movement of the body in relation to objects in the environment
Sensory Integration Therapy

- As the child participates in movements, sensory information from the proprioceptive, vestibular, and tactile systems is produced requiring the nervous system to process, organize, and integrate the information.
Tactile Dysfunction

Characteristics
Child-Oversensitive to touch may:

- Demonstrate tactile defensiveness
- Exhibits “fright or flight” response to harmless touch
- Dislike brushing teeth or having hair cut
- Be bothered by sock seams, tags in shirts, shoes, etc.
- Be a picky eater, avoiding certain textures
- Have poor peer relationships

(Kranowitz, 2003)
Child-Underresponsive to touch may:

- Touch people/things constantly
- Shows little reaction to pain, gets hurt without realizing it
- Physically hurt others without knowing it
- Invades others’ space
- Chews on inedible objects frequently (fingernails, hair, collars, pencils)  
  (Kranowitz, 2003)
Child with Poor Tactile Discrimination may:

- Seem out of touch with hands, as though they are unfamiliar appendages
- Have trouble holding/using tools (pencils, scissors, forks)
- Be clumsy when zipping, buttoning, tying shoes, adjusting clothes
- Squirm or sit on edge of chair

(Kranowitz, 2003)
Activities

For the Tactile Sense
Activities: Tactile Sense

- Shaving Cream: Window clings, mirror or window, shaving cream

- Auditory targets (beginning listener):
  1. Suprasegmentals of speech
  2. Vocabulary (1 vs. 2 or more syllables)
  3. Sound “on” vs. “off” awareness
Activities: Tactile Sense

- Live rabbit or other pet, pet food, Easter grass
- Speech/Auditory targets:
  1) Auditory Comprehension: Follow commands: “Give him some (food type)” or “Show me the rabbit’s (body part)”
  2) Expressive vocabulary, length, and complexity: Have child describe the way the rabbit feels (soft, fluffy), describe the sounds the rabbit makes when he’s eating (carrot-crunchy).
  3) Language web (Older children): Categories (animals, types of food, habitats, etc).
Fish Unit

- Textures: wet paint, sequins, glue
- Animal vocabulary
- Label parts of animals
- Animal habitats
- Social language: What kind of pet do you have at home?
- Print awareness: word to picture
Making Jello

- Textures: dry jello, water, refrigerated jello
- Present progressives: pouring, stirring, mixing, eating
- Pronouns: my turn, her turn, your turn, his turn
Activities: Tactile Sense

- “Buried Treasure”: counting bears, sorting tray, bucket, tongs, sand (Crisp, 2006)
- Speech/Auditory Targets:
  1) Descriptive Vocabulary: colors, describe way sand feels
  2) Discriminate words varying in syllables: bear vs. bucket
  3) Verbs: dig, bury, cover, scoop
  4) Position concepts: in, under, etc.
  5) Where questions: “Where’s the blue bear?”
Activities: Tactile Sense

- Sand Dunes: dry sand, spray bottle with water, toy beach critters, cookie cutters
- Spread sand on tray, spray water until damp, mold sand into dunes and play “beach” with toys
- Draw in sand with fingers
- Use cookie cutters to cut out shapes
- Speech/Auditory Targets: unit vocabulary, descriptive language, 1-2 part auditory directions

(Kranowitz, 2003)
Painting Pumpkins

- Textures: outside/inside of pumpkin, wet paint, water
- Label parts of pumpkin: shell, stem, seeds, pulp
- Describe texture of pumpkin: smooth, sticky, rough, ridges
Activities: Tactile Sense

- DRESS UP:
  - Fancy clothes (bridal veils, satin fabric, etc)
  - Uniforms/professional outfits (nurse, doctor, soldier, cowboy, clown, princess)
  - Scarves, neckties, ribbons, aprons
  - Feathery boas, old fur jackets, woolen shawls
  - Hats, caps, headbands; belts; goggles/glasses
  - Shoes: high heels, slippers, sandals, clogs, boots
  - Costume jewelry

(Kranowitz, 2003)
Activities: Tactile Sense

- Dress-up good for children not yet ready for wet textures
- Helps improve fine motor skills: buttoning, zipping, tying
- Speech/Language: Community helpers vocabulary, adjectives (describing outfits and textures), language webs
- Imaginary play promotes social appropriate behaviors and language

(Kranowitz, 2003)
Benefits:

- Hands-on experimenting with different textures improves tactile perception, body awareness, and creativity
- Squirting shaving cream and manipulating small objects improves hand-eye coordination
- Pushing toys through shaving cream or other textures improves kinesthetic awareness, fine motor skills, and visual-motor integration
- If child refuses to touch textures, offer a stick, spoon, or straw to begin

(Kranowitz, 2003)
Planting Flowers

- Receptive/Expressive Vocabulary: flowers, types of flowers

- What questions: What do the flowers need to grow?

- Sequencing: First, plant the seed; then, water it; then put out in the sun, etc.
Mitten Patterns

- Cut mitten out of stiff paper
- Eye-hand coordination (following line)
- Materials: cardstock or file folder, yarn, cotton balls, glue, sequins, scraps of colored paper
- Vocabulary
- Present progressives (cutting, gluing)
Snow Day

- Tactile: feel the snow
- Eye-hand coordination
- Descriptors: cold, wet, crunch
- Verbs: scoop, dump, pour, pack, roll
- Turn-taking: my turn, your turn
- Tolerance of movement, proximity
Proprioceptive Dysfunction

Characteristics
Proprioception: What does it do?

- Increases body awareness
- Contributes to motor control/motor planning
- Allows us to walk smoothly, run quickly, climb stairs, carry things, sit, stand, stretch, and lie down
- Gives us emotional security (when children trust their bodies, they feel safe and secure)
Child with inefficient, integration of joint/muscle sensations may:

- Have poor sense of body awareness
- Be stiff, uncoordinated, clumsy, falling frequently
- Lean, bump, or crash against objects and people (invades others’ personal space)
- Manipulate hair clips, lamp switches, and pencils so hard that they break
- Pull/twist clothing, chew sleeves/collars
- Difficulty climbing/going down steps

(Kranowitz, 2003)
Proprioception

- The perception of movement and position of the body parts in relation to one another

- This tells us where our body is and what it is doing

- Measured by receptors found in muscles, tendons, and joints
Proprioception

- Purposes:
  - 1) Spatial orientation
  - 2) Rate and timing of movements
  - 3) Force and acceleration of muscle strength
  - 4) Affects a child’s body scheme and motor planning
Motor Planning

- Motor planning bridges motor actions and cognition and occurs when new movements are executed.

- Movements that are repeated are learned by our brain and body and become automatic, no longer requiring a motor plan.
Body Awareness

- Body awareness is an internal awareness that allows us to know where we are, what position we are in, and how we are moving.

- It provides information on body boundaries, where our bodies end and the environment begins.
Body Awareness

- Body awareness allows us to move without having to rely on the visual system to guide each movement.

- How do you know if you’re putting on your shoe if you’re not looking?

- This skill is created over time through many sensory experiences that are stored in our brains.
Body Awareness

- Children who are deprived of sensory experiences or children who are not registering and processing sensory information accurately do not create this internal awareness.

- Therefore, the quality of movement is affected.
Gravitational Insecurity

- An over-sensitivity to vestibular information
- Intolerance and fear of excessive movement
- These children dislike having their feet off the ground and being on unstable or uneven surfaces
- They do not like playground equipment or having their heads inverted
Alphabet Activities

- Letter Identification
- Textures: glue, sticks, feathers
- Letter vocabulary: straight lines, curvy lines
- Proprioceptive: Making letters with your body
- Tactile: Tolerating close proximity
Building Roads

- Vocabulary: transportation (cars, trucks, motorcycles), construction, parking garage, intersection
- Building roads on paper (each piece of paper has a letter; match blocks to lines)
- Promotes imagination (creating roads independently)
- Encourages socialization (working with a friend)
- Eye-hand coordination
Nature Walk

- Touch: branches, sticks, leaves, grass, dirt, flowers, bugs, pinecones, gumballs

- Eye-hand coordination (pick object up, place in the bag)

- Eye-body coordination (walking, squatting to pick object up)
Gravitational Insecurity

- Child’s motor skills may be delayed since they avoid movement

- Child may experience car sickness

- Eye-hand coordination and eye-body coordination tend to be poor because the connections between the visual and vestibular systems are not strong
Activities: Proprioceptive Dysfunction

1) Jump rope rhythms (Ex. Cinderella)

2) Rope activity: child walks along rope on ground, adult plays drum while child marches with beat (Ex. Ten Little Indians)

Speech/Language: Rhythm/intonation, auditory memory, sequencing, loud/soft concepts, thematic vocabulary (Ex. Thanksgiving)
Activities: Proprioceptive Sense

- Pound Cookies: prepared cookie dough, sweet/hard candies, gallon-size, zip-up plastic bags, small hammer or wooden mallet, cookie sheet, cookie cutters, and other cookie baking items

- Activity: Child opens bag of candies, count 5-10 candies, put them in plastic bag. Let air out of bag, then zip it up. Pound candies with hammer/mallet until they are sprinkles. Sprinkle pounded candies on top of cookies.
Activities: Proprioceptive Sense

- Pounding with vigor improves proprioception and force, releases energy, and increases gross motor skills

- Counting candies, sprinkling sprinkles, and using tools all improve fine motor skills

- Speech/Language: Counting, cooking related vocabulary, language webs, adjectives (describing cookies: taste, smell, etc).

(Kranowitz, 2003)
Activities: Proprioceptive Sense

- Perform household chores: sweep, mop, dust, wipe off the table after snack, clean windows, put large toys away
- While on hands/knees, color a “rainbow” with crayons on large butcher paper on the floor or with sidewalk chalk outside
- Play “cars” under the therapy table, pushing with one hand, while creeping/weight bearing with the other hand
- Do animal walks (crab walk, bear walk, army crawl)

(Kranowitz, 2003)
Vestibular Dysfunction

Characteristics
Vestibular System

- This system measures movement and the pull of gravity
- Measured by the semi-circular canals in the inner ear
- Detects angular, rotary, and linear movement
Vestibular System

- Purpose: To register information about movement and to elicit muscles in the neck, trunk, and limbs to react to the movement to support the body.

- The vestibular system affects a child’s balance, muscle tone, bilateral integration, development of hand dominance, alertness, ability to attend, and the nervous system.
Child-Oversensitive to Balance and Movement may:

- Be intolerant to movement, try to avoid it
- Overreact to ordinary movement
- Dislike physical activities (running, biking, etc)
- Dislike using playground equipment
- Be cautious, slow-moving, doesn’t take risks

(Kranowitz, 2003)
Child-Underresponsive to balance and movement may:

- Crave intense, fast, and spinning movement
- Be a thrill-seeker or daredevil
- Need to constantly move in order to function (fidgets, shakes leg, etc)
- Have poor balance, falls easily
- Bumps into objects on purpose

(Kranowitz, 2003)
Child-Poor Discrimination of Balance and Movement may:

- Easily loses balance (climbing stairs, riding bike, standing on one foot)
- Move in uncoordinated, awkward manner
- Have low muscle tone (loose, floppy)
- Have poor posture
- Have difficulty remaining upright when seated

(Kranowitz, 2003)
Activities: Vestibular Sense

- Have child balance on large exercise ball

- Then sing/participate in body movement songs: Clap, Clap, Clap your hands; Head, shoulders, knees and toes; This old man, he played one

- Speech/language: Promotes sequencing, auditory memory, pitch/rhythm/intonation, receptive/expressive vocabulary (body parts), appropriate speech rate
Sensory Strategies

For the Classroom
Sensory Processing

- For over-stimulated child, provide quiet, “time-out” spaces to help child regroup and become organized (ex. A reading corner behind the bookshelf, under a table with pillows or bean bag chair in a quiet corner)
Sensory Processing

- For the child with tactile defensiveness, allow for minimal classmate contact (ex. Put child at end of line, arrange classroom seating so that he/she is not jostled/touched by classmate)
Sensory Processing

- Tactile defensiveness: Modifications to art activities
- Be aware of materials such as glue, finger paints, clay, etc.
- Use tools (i.e. hammer, paint brush) to help keep child involved
Sensory Processing

- Notify child of any upcoming loud noises such as fire alarm
- For the “active” child, allow her to stand at the table while working (or help teacher pass out papers....walking around the room)

(Koomar, et. al, 2005)
Sensory Processing

- For children with low oral/postural tone, allow gum chewing or hard candy to suck during writing activities (check with parent/school)
- This helps to encourage more fine motor control

(Koomar et. al, 2005)
Fine Motor Skills: Writing

- Working on vertical surfaces (helps child strengthen shoulder/wrist muscles for writing) (blackboard, easel, paper taped to wall)
- Provide spray bottle to squirt water onto a picture
- Tweezers to pick up cotton balls
- Beads, sequins to make collages
Fine Motor Skills: Control

- Hole Punch
- Push pegs into clay
- Cut cardboard
- Pick up small objects with tweezers
- Legos
- Tinkertoys
- Origami
- Find “hidden” objects in Silly Putty

(Koomar et. al, 2005)
Motor Planning and Organizational Strategies

- Give simple step-by-step directions
- Demonstrate task or ask another child to “model” the activity first
- Help child with task planning “What materials do you need?” “What do you do first?”
- Play “Simon Says” or other sequencing games
Motor Planning and Organizational Strategies

- Use timer to prepare child for transitions
- Use pictures or written list on blackboard (daily routines); Helps makes transitions smoother
- Supplement handwriting with other methods of written expression (typing on keyboard; computer games)
Work Activities

For children requiring “increased” input
Work Activities

- Place chairs on desks at end of day
- Take chairs off desks at beginning of day
- Wash desks or chalkboard
- Rearrange desks in classroom
- Help empty trashcans

- Take chewy candy breaks (licorice, fruit roll-ups, Tootsie Rolls)
- Take crunchy food breaks (popcorn, pretzels, dry cereal)
- Sharpen pencils with manual sharpener
- Staple paper onto bulletin boards
Work Activities

- Climb on the playground equipment
- Perform sports activities that involve running and jumping
- Run around the track at school
- Have students “push” against the wall (make it a game: “Let’s make the room bigger!”)
- Jump on a mini-trampoline
- Stack chairs
- Do animal walks (crab walk, bear walk, army crawl)
- Allow the child to use “squeeze toys” silently at his desk

(Haber & Iris Sava, 2001)
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